TT 57: Topological Semimetals III

Time: Wednesday 10:00–11:15 Location: A 053

TT 57.1 Wed 10:00 A 053

Anomalous Hall effect in topological magnetic materials — •Kaustuv Manna[1], Lukas Muechler[1,2], Ting Hui Kao[1], Rolf Stinshoff[1], Nitesh Kumar[1], Jürgen Kübler[1], Gerhard H. Fecher[1], Chandra Shekhar[1], Yan Sun[1], and Claudia Felser[1] — [1]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [2]Department of Chemistry, Princeton University, Princeton, NJ, USA

In recent years, topological semimetals have emerged as a new frontier in the condensed matter community. With the interplay between the structural asymmetry and spin-orbit interaction, and details of Berry phase, new topological states are being discovered. Though inversion symmetry breaking Weyl fermion is demonstrated in TaAs family of compounds, the time-reversal breaking examples remain elusive. Here we demonstrate the formation of magnetic nodal lines in a topological magnetic Heusler compound Co_2MnGa. Without spin-orbit coupling (SOC), we find three nodal lines due to the band crossing in majority spin channel. With SOC, nodal lines split up giving rise to the Weyl nodes, whose momentum space distributions depend on the magnetization direction. We observe giant anomalous Hall conductivity of 1600 Ω^{-1}cm^{-1} with room temperature anomalous Hall angle 12% in Co_2MnGa. In- fact, by suitable manipulations of the crystal symmetries and the band structures of the materials, one can selectively tuned the anomalous Hall conductivity from 0 to values up to 1600 Ω^{-1}cm^{-1} in various magnetic Heusler compounds for next-generation topo-spintronics applications.

TT 57.2 Wed 10:15 A 053

Evolution of the surface states of the Luttinger semimetal under compressive strain and broken inversion symmetry: relation to Dirac and Weyl semimetals — •Julian-Benedikt Mayer, Maxim Kharitonov, and Ewelina Hankiewicz — Institute for Theoretical Physics and Astrophysics, Würzburg, Germany

Luttinger semimetal, the quadratic-node semimetal for $j = 3/2$ electrons under full cubic symmetry, is the parent highest-symmetry minimal model for a variety of topological and/or strongly correlated materials, such as HgTe, α-Sn, and iridate compounds. Recently, Luttinger semimetal has been demonstrated [1] to exhibit surface states of topological origin that can be attributed to approximate chiral symmetry. In the present work, we theoretically study the effect of the symmetry-lowering perturbations on these surface states within an analytical model. Under compressive strain lowering rotational symmetry, Luttinger semimetal becomes a Dirac semimetal with a pair of double-degenerate linear nodes. Breaking further inversion symmetry, the system turns into a Weyl semimetal, with each Dirac node split into four Weyl nodes [2]. We analyze the corresponding evolution of the surface states, connecting the surface-state structures in the linear regime near the nodes and in the quadratic regime of the Luttinger semimetal away from the nodes. In particular, we demonstrate agreement of the Chern numbers with the chiralities of the surface states.

[1] M. Kharitonov, J.-B. Mayer, and E. M. Hankiewicz, Phys. Rev. Lett., in press; arXiv:1701.01553 (2017).
[2] J. Ruan, S.-K. Jian, Yao, H. Zhang, S.-C. Zhang, and D. Xing, Nature Comm. 7, 11136 (2016).

TT 57.3 Wed 10:30 A 053

Appearance of the universal value e^2/h of the zero-bias conductance in a Weyl semimetal-superconductor junction — Songbo Zhang[1], •Fabrizio Dolcini[2], Daniel Breunig[1], and Björn Trauzettel[1] — [1]Institute for Theoretical Physics and Astrophysics, University of Würzburg, D-97074 Würzburg, Germany — [2]Dipartimento di Scienza Applicata e Tecnologia del Politecnico di Torino, I-10129 Torino, Italy

We study the differential conductance of a time-reversal symmetric Weyl semimetal-superconductor (N-S) junction with an s-wave superconducting state. We find that there exists an accessible regime where the zero-bias differential conductance acquires the universal value e^2/h per unit channel, independent of the pairing and chemical potentials on each side of the junction, due to a perfect cancellation of Andreev and normal reflection contributions. This universal conductance can be attributed to the interplay of the unique spin/orbital-momentum locking and s-wave pairing that couples Weyl nodes of the same chirality. We expect that the universal conductance can serve as a robust and distinct signature for time-reversal symmetric Weyl fermions, and be observed in the recently discovered time-reversal symmetric Weyl semimetals.

TT 57.4 Wed 10:45 A 053

Exploring the Quantum Limit of Weyl semimetal candidates — •Tobias Förster[1], Johannes Klotz[1,2], Jochen Wosnitza[1,2], Chandra Shekhar[3], Binghai Yan[3], and Claudia Felser[3] — [1]Dresden High Magnetic Field Laboratory (HLD-EMFL), Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Institut für Festkörper- und Materialphysik, TU Dresden, Germany — [3]Max Planck Institute f. Chemical Physics of Solids, Germany

Non-centrosymmetric transition-metal mono-pnictides such as NbAs, NbP and TaAs attracted a lot of attention because their bandstructures show linear non-degenerate band crossings, dubbed Weyl nodes [1,2]. Additionally, for certain magnetic-field orientations, the highest de Haas-van Alphen frequencies observed are smaller than 50 T. For that reason, all bands are expected to be in the quantum limit at fields easily reachable by pulsed magnetic fields. Thus, these semimetals constitute an ideal playground to study the quantum limit by electric transport and magnetic-torque measurements. Our first results for NbP show an unexpected linear increase in magnetic-torque measurements. In our contribution we show the results of our magnetic-torque measurements on NbP, NbAs, TaP and TaAs in pulsed fields up to 70 T.

[1] J. Klotz *et al.*, Phys. Rev. B. **93** 121105 (2016).
[2] C. Shekhar *et al.*, Nat. Phys. **11** 645 (2015).

TT 57.5 Wed 11:00 A 053

Anomaly transport in graphene and Weyl semimetals normally explained — •Klaus Morawetz — Münster University of Applied Sciences,Stegerwaldstrasse 39, 48565 Steinfurt, Germany — International Institute of Physics- UFRN,Campus Universitário Lagoa nova,59078-970 Natal, Brazil — Max-Planck-Institute for the Physics of Complex Systems, 01187 Dresden, Germany

Based on the quantum kinetic equations for systems with SU(2) structure, regularization-free density and pseudospin currents are calculated in Graphene and Weyl-systems realized as the infinite-mass limit of electrons with quadratic dispersion and a proper spin-orbit coupling. Correspondingly the currents possess no quasiparticle part but only anomalous parts. The intraband and interband conductivities are discussed. The optical conductivity agrees well with the experimental values using screened impurity scattering and an effective Zeeman field. The universal value of Hall conductivity is shown to be modified due to the Zeeman field. The pseudospin current reveals an anomaly since a quasiparticle part appears though it vanishes for particle currents.

[1] Phys. Rev. B 94 (2016) 165415,
[2] Phys. Rev. B 92 (2015) 245425
[3] errata: Phys. Rev. B93 (2016) 239904(E)
[4] Phys. Rev. B 92 (2015) 245426